AD-A071 078 NAVAL POSTGRADUATE SCHOOL MONTEREY CA F/G 5/9
AN EXAMINATION OF TWO FORMAL SCHOOL INITIAL SPECIALIZED TRAININ--ETC(U)
MAR 79 N A COMMONS

UNCLASSIFIED NL

1 OF 1
AD
A071078

END
DATE
FILMED
8-79
DDC

NAVAL POSTGRADUATE SCHOOL

Monterey, California

(9) Master's THESIS

(6) AN EXAMINATION OF TWO FORMAL SCHOOL INITIAL SPECIALIZED TRAINING PIPELINES WITH RESPECT TO RETENTION

by

(10) Norbert Anthony Commons, Jr.

(11) March 1979

(12) 68p.

Thesis Advisor: J.K. Hartman

Approved for public release; distribution unlimited.

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER

2. GOVT ACCESSION NO.

3. RECIPIENT'S CATALOG NUMBER

4. TITLE (and Subtitle)
An Examination of Two Formal School Initial Specialized Training Pipelines With Respect to Retention

5. TYPE OF REPORT & PERIOD COVERED
Master's Thesis; March 1979

6. PERFORMING ORG. REPORT NUMBER

7. AUTHOR(s)
Norbert Anthony Commons, Jr.

8. CONTRACT OR GRANT NUMBER(s)

9. PERFORMING ORGANIZATION NAME AND ADDRESS
Naval Postgraduate School
Monterey, California 93940

10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS

11. CONTROLLING OFFICE NAME AND ADDRESS
Naval Postgraduate School
Monterey, California 93940

12. REPORT DATE
March 1979

13. NUMBER OF PAGES
67

14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)

15. SECURITY CLASS. (of this report)
Unclassified

15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Initial Specialized Training Pipelines

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This thesis examines two formal school initial specialized training pipelines in order to determine if the present distribution of personnel in these pipelines could be modified to yield a higher retention rate. Over 80% of bootcamp graduates go directly to an initial specialized training "A" school while only about 3% take the delayed school pipeline and return to "A" school after having been to a fleet assignment following bootcamp. After

#20 - ABSTRACT - CONTINUED

making an adjustment to account for the loss that occurred during this time delay for the delayed school pipeline, a regression analysis was done to determine the effect of certain demographic characteristics on retention. The regression was then used in combination with the loss adjustment to predict the marginal retention rate for individuals shifted from the direct to the delayed pipeline. It was found that marginal retention rate could be increased nearly 50% by greater utilization of the delayed training pipeline and at a significant reduction in training load. Such a shift would also result in a more preferable manning profile in the fleet because it produces more untrained sailors with less than one year experience where presently shortages result in "A" school graduates being initially assigned menial tasks outside their specialty.

An Examination of Two Formal School Initial Specialized Training Pipelines With Respect to Retention

by

Norbert Anthony Commons, Jr.
Lieutenant Commander, United States Navy
B.A., University of Texas, 1967

Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN OPERATIONS RESEARCH

from the

NAVAL POSTGRADUATE SCHOOL
March 1979

Author: N. A. Commons Jr.

Approved by: J. K. Hartman, Thesis Advisor

H. J. Larson, Second Reader

Michael G. Sovereign, Chairman, Department of Operations Research

Dean of Information and Policy Sciences

ABSTRACT

This thesis examines two formal school initial specialized training pipelines in order to determine if the present distribution of personnel in these pipelines could be modified to yield a higher retention rate. Over 80% of bootcamp graduates go directly to an initial specialized training "A" school while only about 3% take the delayed school pipeline and return to "A" school after having been to a fleet assignment following bootcamp. After making an adjustment to account for the loss that occurred during this time delay for the delayed school pipeline, a regression analysis was done to determine the effect of certain demographic characteristics on retention. The regression was then used in combination with the loss adjustment to predict the marginal retention rate for individuals shifted from the direct to the delayed pipeline. It was found that marginal retention rate could be increased nearly 50% by greater utilization of the delayed training pipeline and at a significant reduction in training load. Such a shift would also result in a more preferable manning profile in the fleet because it produces more untrained sailors with less than one year experience where presently shortages result in "A" school graduates being initially assigned menial tasks outside their specialty.

TABLE OF CONTENTS

I. INTRODUCTION

A. THE MANPOWER PROBLEM

Each year the Navy sends more than 80% of its new recruits immediately to an initial specialized training school ("A" school). The criteria used to select the individuals are a battery of test scores. Quite often individuals are guaranteed a particular school assignment as a precondition to enlistment, again based solely on qualifying test scores. Approximately 10% of these individuals will not even complete the first year of their enlistment contracts and at the end of a four year enlistment barely 10% of those completing "A" school will actually be retained.[1]

These figures represent an alarmingly costly and inefficient system for producing trained career designated petty officers.

Unfortunately the alternatives are severely limited. Naval Weapons Systems have become so complex and technologically advanced that nearly all of the occupational areas demand people who have this training. If there was a plentiful supply of manpower and the cost was not prohibitive the demand could be met by recruiting sufficient

---

[1] In this thesis retention figures will be expressed as percents of "A" school graduates, or bootcamp graduates for those that do not attend an "A" school during their first enlistment term.

numbers. But the termination of the draft and the decline in numbers of the recruitable population base have made it impossible for recruiters to meet their present goals in an economically competitive market. This difficulty is expected to become gradually more pronounced at least through the year 2000 [Ref. 11].

B. RETENTION LEVERAGE

The ultimate solution requires a significant shift in the supply and demand position the Navy now holds in the recruiting market. However, every possible opportunity for immediate improvement in the efficiency of the manpower management system must be urgently examined. If, for example, retention could be improved from ten percent to eleven percent, acquisitions could be reduced by ten percent to ninety percent of the present requirements. In numbers this means that retraining one hundred more trained individuals would reduce the required recruit input by one thousand. This brief analysis ignores the secondary manpower gains precipitated by the reduction in training load and the improvement in the average experience level of the total force. Although improving retention is certainly not a trivial issue the leverage it can provide makes it a valuable alternative.

One possible improvement in retention may exist in optimizing manpower distribution in the Navy's training system with respect to retention potential. This thesis

presents an analysis of the current initial specialized training distribution to determine if modifications are indicated that would yield an improved retention.

II. BACKGROUND

A. ALTERNATIVE TRAINING PIPELINES (Refer to figure 1)

There are three paths or pipelines that can be taken by a new recruit enroute to becoming "rated" in a particular occupational specialty. Two of the three involve completion of a formal "A" school. The third pipeline accomplishes its training on the job (OJT).

1. Formal School Pipelines

a. Direct "A" school

All non-prior service recruits attend bootcamp. Upon completion of bootcamp approximately eighty percent will proceed directly to an "A" school. As mentioned in the introduction, qualification for this training is based solely on a battery of aptitude examination scores known as the Armed Services Vocational Aptitude Battery (ASVAB).

Upon completion of their respective schools individuals in this pipeline will be ordered to a fleet assignment. It is highly probable that the first three months of this assignment will be spent performing various menial tasks quite unrelated to their occupational specialties. This is because there is always more of this kind of work (barracks cleaning, mess cooking, paint chipping, etc.) to be done than there are people to do it. At the end of this indoctrination period they will proceed to a work center compatible with their schooling.

b. Delayed "A" school

Those who do not go to an "A" school immediately after bootcamp are given a two or four week apprentice training in one of the three general rating groups as apprentice seasmen (2 weeks), airmen (2 weeks), or firemen (4 weeks). They are then ordered to their first fleet assignment.

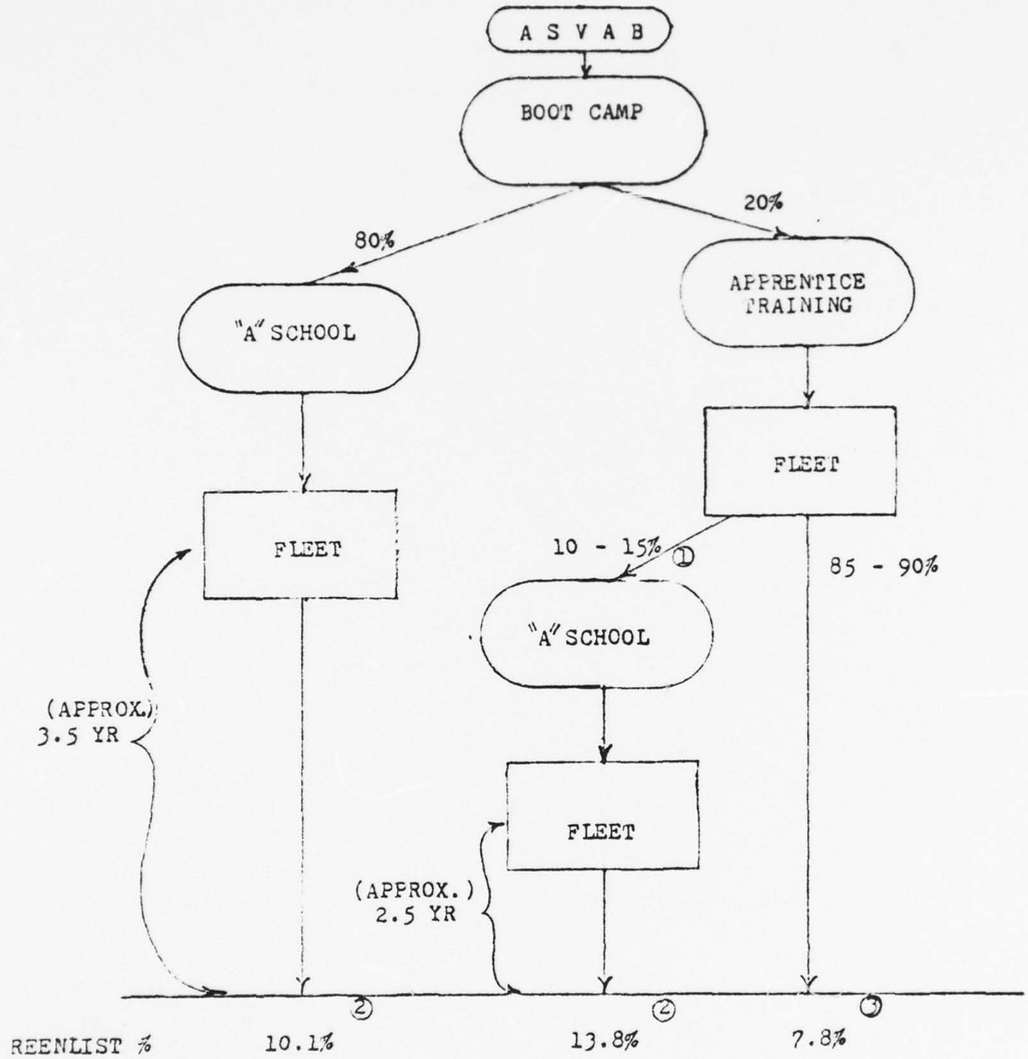
At any time during their first enlistment individuals in this group may request and be accepted for an "A" school. By the end of their first enlistment term some ten to fifteen percent will proceed along this training path. Having gained some seniority this group is traditionally utilized in their occupational specialty immediately upon their return to an operational assignment.

This group will include many who could not have qualified for an "A" school with their original ASVAB scores. They can, however, qualify as a delayed school input by being granted a five point waiver for each test score required in order to qualify for a particular school. Since some schools require a combined score total from three aptitude areas, this waiver could be as much as fifteen total points. This waiver is granted in recognition of the demonstrated performance and motivation implicit in a recommendation by the individual's commanding officer.

2. <u>On the Job Training</u>

There are some occupational specialities for which satisfactory completion of the appropriate A school is

TRAINING PIPELINES



1. This delayed input occurs at any point during the first enlistment, but averages about a one year delay.

2. Expressed as a percentage of the "A" School graduates in this pipeline.

3. Expressed as a percentage of all bootcamp graduates that did not complete any "A" School.

Figure 1

required, but there are also many that accept on-the-job training applicants or "strikers" as they are called, as well. There are, in fact, a few occupational specialties for which no "A" school exists and training must be done via OJT. It will be assumed for this thesis that for those occupational specialites in which it is possible to qualify either through "A" school or OJT that the formal school training is more efficient and desirable because it reduces the already considerable training burden of the operating units, produces a consistently high quality product and because it results in standardization and the application of modern specialized training technology. For this reason the on-the-job training pipeline has not been examined in this thesis.

B. OBJECTIVES

1. The ENACT Study Plan

The Center for Naval Analysis has been tasked by the Director, Systems Analysis Division (OP-96) as part of the Enlisted Accession and Training (ENACT) study to examine initial specialized training strategies. In paragraph 13 of the ENACT Study Plan, CNA's initial approach to this problem is presented as follows [Ref. 2].

> (1) Emphasis of this task will be placed on those ratings or occupational groupings of ratings for which manpower shortages are forecast in the first six years of service.
>
> (2) The possibility of increasing the number of first termers who are significantly delayed in their assignment to A

school will be examined. The purpose of this examination is to determine if such a delay can effectively cull those individuals with poor continuation behavior, thus avoiding wasted training costs without adversely affecting the fleets operational capability by imposing large OJT requirements.

(3) The possibility of adjusting the qualifications for assignment to A school to reflect projected continuation behavior will be examined. The purpose of this examination is to determine if such adjustments can produce substantial improvements in trained man-years by not allowing individuals with projected poor continuation behavior to receive such training.

(4) The general approach to alternatives will be conservative in that it is considered desirable to minimize their short term impact on the fleet. No formal attempt will be made to measure that impact in terms of changes to the operational capabilities of the fleet. Alternatives will be stated in terms of trained man-years gained or lost compared to current conditions and evaluated on that basis.

2. <u>Discussion of ENACT Objectives</u>

This plan presents several alternatives and some of the important relationships. It does not however, clearly differentiate the cost reduction objective from that of increasing the number of trained man years. If this difference is not understood it is possible that the resulting recommendations will suggest an infeasible suboptimization.

There are, therefore, two separate issues which can be but are not necessarily opposed. The first is the need to reduce the high marginal cost of sending a very high percentage of individuals directly to "A" school based

only on test scores. The second is the need to increase the number of trained man years.

It is theoretically possible to improve retention by a greater utilization of the delayed "A" school paths. This would occur if individuals were somehow more motivated by having earned their schooling and having had the experience of being rewarded for their good performance. This program also affords individuals an opportunity for a more intelligent selection of occupational specialty which could also have a positive impact on retention through greater job satisfaction.

In this way the two objectives can be brought into agreement by taking a long term positive approach. Only an increase in the number of reenlisted trained individuals who can then be expected to remain as career designated petty officers for a relatively long time period can compensate for the immediate loss in trained man years precipitated by the delayed A school pipeline. Conversely, if the delayed A school pipeline does not lead to improved retention then the two objectives are bipolar and only tradeoffs exist.

C. FEASIBILITY

Before attempting an in-depth analysis of the training pipelines, it was first necessary to determine if the effect on the operating units of a decrease in direct "A" school input would be acceptable. Since this change would not be

made unless a retention improvement could be expected from the increased delayed "A" school's input, a slight retention improvement was assumed in the feasibility check. If the resulting manning profile thus developed had not been acceptable then the plan would have been infeasible.

1. Analysis

The analysis was done informally by constructing a rough estimate of the current manning profile and comparing this to an estimate for a system in which 75% of the recruit training graduates went to the fleet instead of directly to A school. The two profiles were quite distinct in this comparison. This was admittedly an extreme modification but the intent was to show a dramatic shift sufficient to elicit dissenting opinions if the change was undesirable.

The manning profile was defined as follows: non "A" school personnel with less than one years fleet service (F1-); non A school first term personnel with more than one years fleet service (F1+); first term direct A school graduates (DA); first term delayed "A" school graduates (FA) and career designated personnel (CD). The relative percentages under the two hypothetical cases are tabled in figure 2. A full explanation of the derivation of figure 2 is contained in Appendix A.

ALTERNATIVE MANNING PROFILES

	Current System (Approx. 75%[1] Direct Input)	Modified System (Approx. 25%[1] Direct Input)
F1-	4.8	13.5
F1+	17.0	17.8
DA	45.3	15.4
FA	1.2	19.0
CD	31.7	34.3

[1]Percent of Bootcamp Graduates

Figure 2

Four officers with recent command experience, each in a different warfare specialty area, were interviewed and shown the results in figure 2. All four indicated a preference for the modified system and all four listed the same primary reason, i.e., a severe shortage of personnel in the F1- category. Because of this shortage newly arrived "A" school graduates usually spend their first few months performing menial tasks well apart from their training specialty. This is quite often a highly demotivating experience because of the high expectations acquired during technical training.

2. Conclusion

A change as described by the modified system is more than acceptable. It yields a preferred manpower profile if the initial expectation of improved retention can be met. That is not to say that a shift to only 25% direct input is the goal. Such a shift may not be at all compatible with programs such as the school guarantee program used by recruiters as enlistment incentives. What is implied is that the current manning profile is, in the aggregate, unbalanced in favor of direct "A" school first-termers, a situation that could be improved under this proposed change.

D. FOCUS AND SCOPE

This thesis, therefore, focused on the retention issue and attempted to determine if the delayed training path

does yield a higher expected retention percentage. To do this the two formal school pipelines were compared with respect to reenlistment after compensating for certain known pipeline differences. Emphasis throughout was placed on understanding possible cause and effect relationships that might be hypothesized from the mathematical results.

No attempt was made to differentiate the various occupational subgroups because the reduction in size of the data set in each subgroup would have been incompatible with the regression model used.

The interface with recruiting was also considered beyond the scope of this thesis, although programs such as the guaranteed "A" school recruiting incentive must certainly be coordinated with any specific pipeline changes.

E. DATA BASE

The population base used in this study consisted of the non-prior-service male recruits that enlisted in the regular navy in calendar year 1973. This population numbered just under 50,000. After selecting out other than four year enlistments (8338) and recruit training losses (5469), 35,802 non-prior-service males that enlisted for four years and completed recruit training were left.

The data set for this population was provided by C.N.A. It consisted of a longitudinal record tracking each individual through four years of service, including a reenlistment period. A relatively small portion of the data was

required for this analysis. This was because previous studies at CNA had succeeded in establishing the independent variables that might effectively be used as predictors of continuation behavior [Refs. 1-5].

Dividing the data set into the various pipelines was accomplished by locating the individuals having an "A" school completion code and comparing the completion date to the initial seaduty/shore duty data. Unfortunately since only "A" school completion codes are provided there was no direct method of determining who had been sent to an "A" school but had failed to complete the school. Without this information attrition figures could not be determined and the complete pipeline could not be mathematically modeled.

Individuals were then placed in cells according to a vector of dummy variables that described five characteristics of each person: mental group category (5), education level (4), age (3), race (2), and dependents (2). See figure 4. The numbers in parenthesis indicate the number of divisions of that particular variable. Multiplying these numbers together yields a total of 240 cells in the model. These cells describe the individual at the time of his enlistment. A check of the reenlistment code on the data tape completed the information required for this analysis.

INDEPENDENT VARIABLES
VALUE ASSIGNMENTS TABLE

A particular variable will be given the value 1 if the individual being described exhibits that characteristic and a Ø otherwise.

MENTAL GROUPS (based on Armed Forces Qualification Test)[1]

MG1 = 1	95-100	
MG2 = 1	67-94	
MG3, UPPER = 1	50-66	These are the only categories accepted for enlistment.
MG3, LOWER = 1	35-49	
MG4 = 1	21-34	

[Note 1: Mental groups are now based on the Armed Services Vocational Aptitude Battery]

EDUCATION LEVELS

ED1 = 1	less than 11 years education
ED2 = 1	11 years education
ED3 = 1	12 years education
ED4 = 1	more than 12 years education

AGE (at enlistment)

AGE1 = 1	17 years of age or younger
AGE2 = 1	18 or 19 years of age
AGE3 = 1	20 years of age or older

DEPENDENTS

DEP = 1	an individual has dependents

RACE

RACE = 1	an individual is non caucasian

III. THE MODEL

A. OVERVIEW

It is obvious from figure 1 that a direct comparison of retention between the two formal school training paths could be very misleading.

Figure 4 illustrates the two known differences for which adjustments must be made in order to compare the two retention rates. These two differences are: time differences from school completion to reenlistment and population differences resulting from the initial selection process.

To eliminate the first difference the time delay for the delayed pipeline was estimated and the direct "A" school population was reduced by an amount equivalent to the estimated loss (number of early discharges) for this time period.

Given this adjusted direct "A" school population base it was possible to adjust for the differences in demographic profile through regression analysis. This regression analysis was done on the delayed "A" school population with retention as the dependent variable and demographic cell descriptors as the independent variables. This equation was then applied to the loss adjusted direct "A" school population base to predict their expected retention behavior under a delayed school path. The

"A" SCHOOL PIPELINES

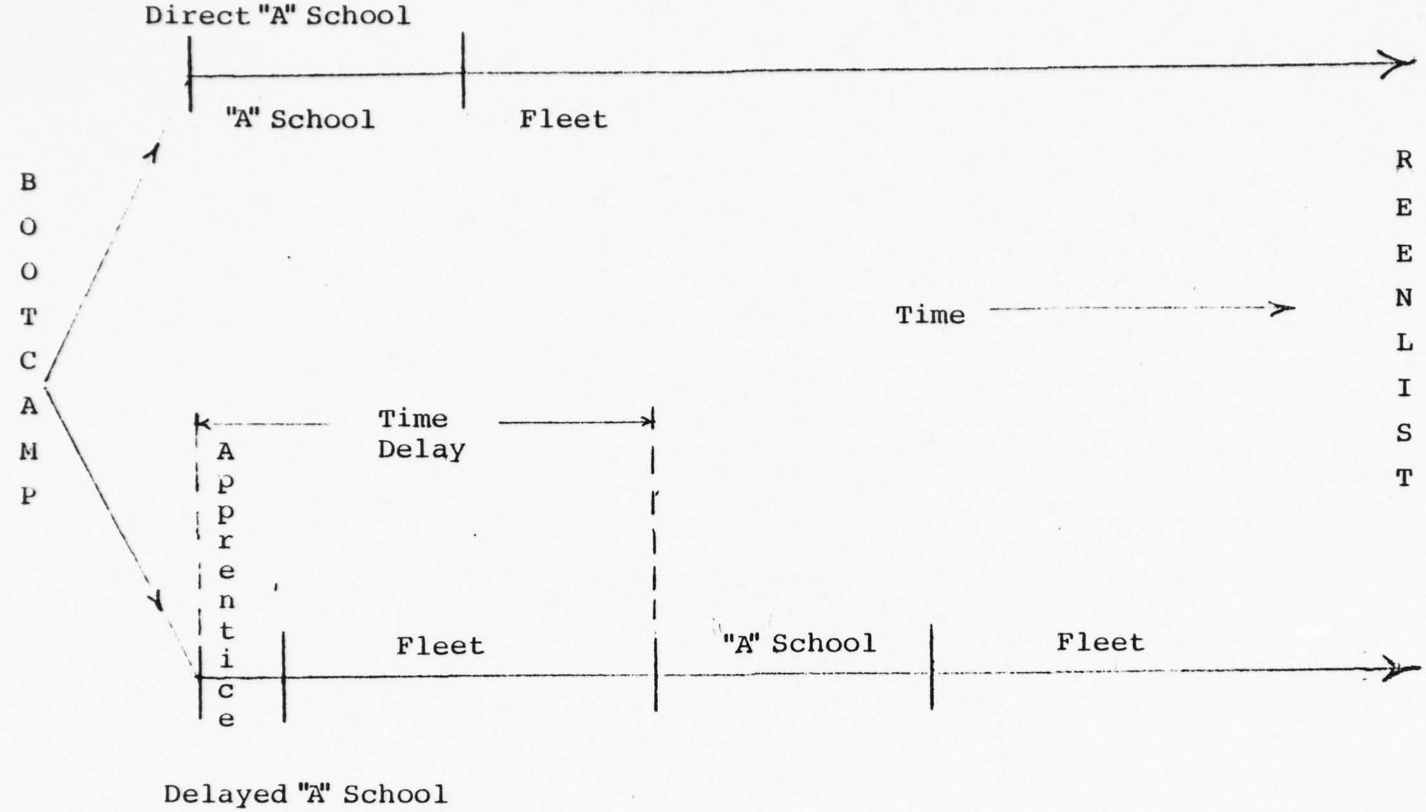


FIGURE 4

assumption is that the direct school population would exhibit a retention behavior similar to the delayed school population given the same training path.

There are two slightly different philosophical approaches to this overall retention comparison. The first approach is to simply compare what has actually happened under the existing system (purely a descriptive process). The second method involves estimating the outcome of a change to the system. The second approach goes one step beyond the first and becomes a predictive comparison. The second approach, being more consistent with the purpose of the study, was used herein.

Although the entire direct A school population was theoretically processed through the delayed "A" school pipeline to develop the retention comparison figures it would be ridiculous to expect the model to be accurate under such a drastic change. Only the various percentages presented should be viewed as predictive in nature and then only for small changes to the existing systems. The absolute numbers of retention are presented for descriptive comparison only.

B. ADJUSTMENT FOR TIME DELAY

The reduction of the direct "A" school population base to reflect the time difference shown in figure 4 involves two estimates: an estimate of the time delay and then an estimate of the loss rate during that time.

1. Estimate of Time Delay

Some of the delayed "A" school people were delayed only because of school availability. Their "A" school was guaranteed before leaving the recruit training center. Individuals in this group will normally return to their school assignments after only a short delay and thus bias the average delay toward the low end. Since it was not possible to accurately separate this subgroup it represents a kind of contamination of this population. It is believed, however, to have a conservative effect on the analysis because it tends to make the delayed and direct school populations more similar rather than more diverse.

A histogram of the time from initial sea duty/shore duty date to "A" school completion date for the individuals in the delayed pipeline is shown in figure 5. Obviously, those with only two or three months time delay are not representative of the true distribution of the delayed population that actually experienced the fleet screening process. However, the time period reflected in figure 5 includes the "A" school training period (see figure 4) which when subtracted out tends to offset the effect of this population contamination. After allowing for the offsetting nature of these two elements a two to four week time period would still have to be added back in for apprentice training.

Because of the difficulties inherent in performing a rigorous calculation of this time delay it was decided

HISTOGRAM OF DELAYED "A" SCHOOL GRADUATES
VS
TIME DELAY[1]

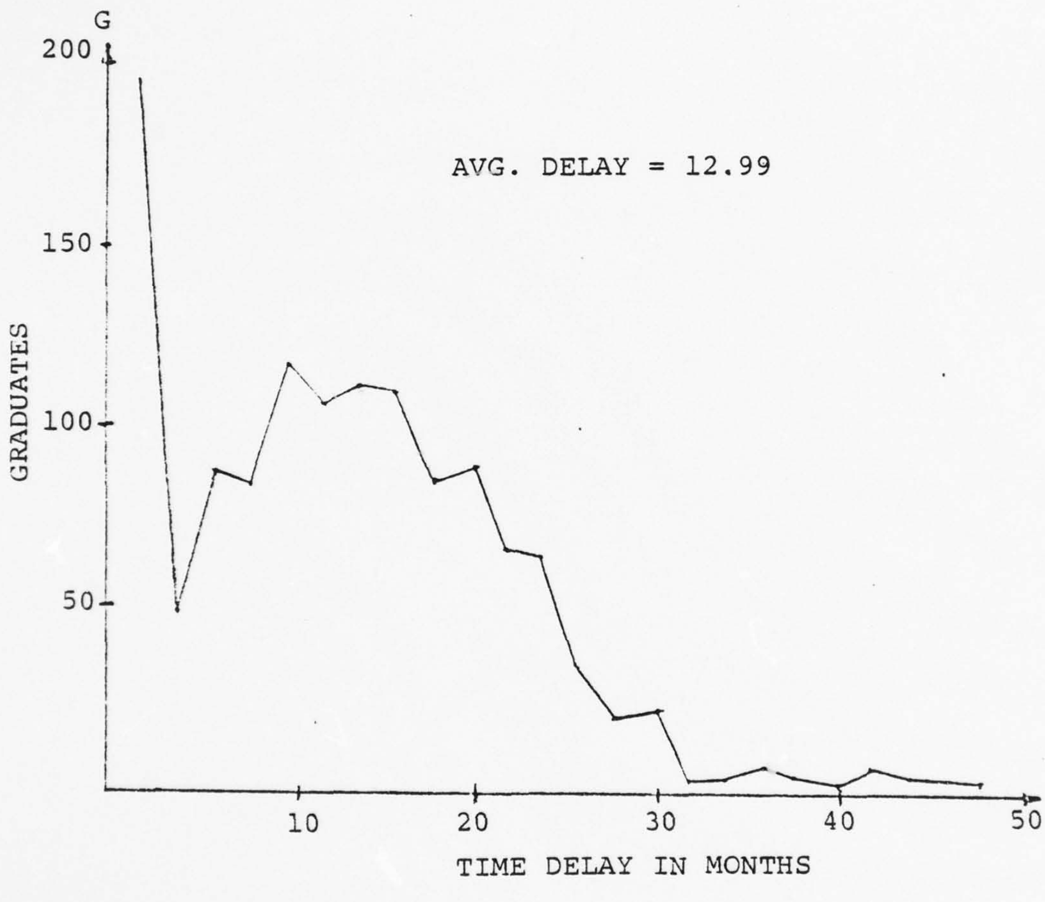


FIGURE 5

[1]Time between first sea duty/shore duty date and "A" school graduation date

that a simple one year estimate of the delay time would be a suitable approximation. Subsequent to making this estimate it was discovered that there was, in fact, a twelve month difference between the two pipelines with respect to expected months of service after "A" school completion during the first enlistment term [Ref. 8].

2. Estimate of Loss Rate

Two separate loss rates were used to develop "best guess" and "worst case" estimates of marginal reenlistment rates. In the worst case comparison the number of direct "A" school graduates in each cell was reduced by 42% [Ref. 3].

$$AN_i = N_i(1 - \hat{P}_L)\ T_D$$

where

- AN_i is the adjusted base number for each cell in the model
- N_i is the original number in the cell
- P_L is the estimated loss rate for all cells (.42)
- T_D is the time delay (estimated to be 1 year)

This reflects the first year loss rate that actually occurred in the group that did not go directly to an "A" school.

A kind of paradox exists here. Although this was treated as the worst case it is also the real observed loss rate. In this sense the figures derived using this loss rate represent the true "descriptive" comparison of reenlistment for the two formal school pipelines under the existing selection process. However, as a predictor for a modified pipeline distribution it is not reasonable to apply this 42% loss rate to individuals from the existing direct "A" school population whose demonstrated loss rate was only 11%. To do so would imply that the total population had a relatively homogeneous behavior pattern in that their first year continuation rate was based heavily on "A" school attendance. It seems more logical to recognize that those who did not complete even their first year of obligated service were a distinct group that was ill-suited for the military system. This group probably did not attend "A" school by choice hence reversing the cause and effect implications. Since the objective of this thesis is to provide guidance for possible system modification the actual loss rate can justifiably be treated as the worst case situation in a "predictive" sense.

The first year loss rate by cell for the entire population was chosen as the best guess prediction for small or marginal increases in delayed inputs to "A" school. This loss rate was available as a result of several studies using the 1973 data base. The Success Chances of REcruits

Entering the Navy (SCREEN) and revised screen studies provided this loss rate information [Ref. 4]. The screen model is a grouped logit model identical in concept to the regression model used in this thesis, but with 1st year losses as the dependent variable. The following calculations of the best guess adjusted population base will, therefore, not be explained in detail, here. The mathematical basis for this model will be explained in a later section.

$$AN_i = N_i(1 - \hat{P}_{Li})\ T_D$$

where AN_i, N_i, and T_D are as explained previously and

$$\hat{P}_{Li} = \frac{e^{\hat{\alpha}_L + \hat{\beta}_L X_i}}{1 + e^{\hat{\alpha}_L + \hat{\beta}_L X_i}}$$

where

$\hat{P}_{Li}$ is the estimated loss rate for cell i, and

$\hat{\alpha}_L + \hat{\beta}_L X_i$ is the logit function which will be explained later.

Substituting for $\hat{P}_{Li}$ yields

$$AN_i = N_i\left(\frac{1}{1 + e^{\hat{\alpha}_L + \hat{\beta}_L X_i}}\right)$$

This method results in a loss rate of about 15% which may be consistent with a slight increase in loss resulting from having "A" school temporarily denied. This smaller increase in loss rate defined according to cell description seems to be a more reasonable behavior modification.

C. POPULATION DIFFERENCES

1. The Regression Model

To eliminate the effect of the population differences a regression model was developed. Because each individual can choose between two alternatives, to reenlist or not to reenlist, the model is called a binary choice model. In this case the regression attempts to describe the probability of one of these choices (thus implying the probability of the other) based on the values of the independent variables. The simplest type of this model is a linear probability model of the form

$$y = \alpha + \beta X + \varepsilon$$

where

- y takes on the values 0 or 1 representing the two choices
- α is a constant
- β is the vector of coefficients to be estimated
- X is the vector of independent variable values

ε is the random error term assumed to be normally distributed with zero mean

This model has the advantage of being easily solved by using the ordinary least squares technique. It does, however, have two important disadvantages with respect to binary choice models. First of all the dependent variable can have predicted values outside the required zero to one probability range. This problem can be artificially solved by changing all predicted values outside the interval to the value of the nearest bound, but that doesn't solve the underlying problem. The characteristic relationship to be described by the regression is not normally linear. This non-linearity is demonstrated by considering two athletic teams one of which won only ten of its twenty games while the other won eighteen of twenty. The first team could perhaps improve its record to 12 wins by practicing one more hour a week. The second team, however, is not likely to be able to win all twenty just by adding another hour to the practice schedule, i.e., a perfect record is much harder to achieve. Relationships that are nearly linear in the mid range of probabilities will be found to diverge from this linearity as the probability of an event approaches zero or one.

A simple transformation of the data yields a model called the logit model in which the cumulative probability of one of the choices is assumed to be distributed as follows:

$$P_i = \frac{1}{1 + e^{-(\alpha+\beta X_i)}}$$

Simple algebraic manipulation and taking the log of both sides yields

$$\log\left(\frac{P_i}{1 - P_i}\right) = \alpha + \beta X_i$$

which can be solved quite nicely by ordinary least squares and the model now exhibits an appropriately non-linear relationship between dependent and independent variables. See figure 6.

$$P = \frac{1}{1 + e^{-(\alpha+\beta X)}}$$

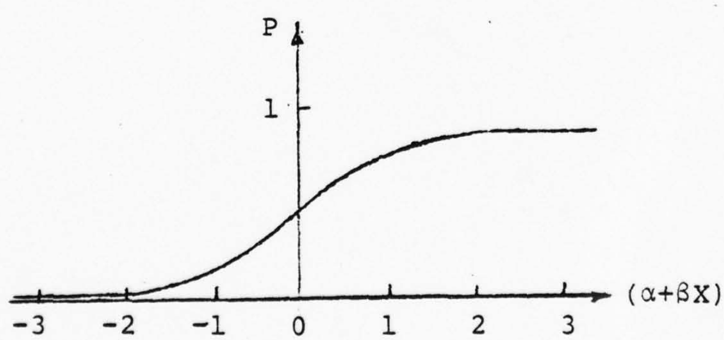


Figure 6

This form of the model requires that the dependent variable be input as a probability which can be done by grouping the data into cells based on the values of the independent variable. Each cell then becomes one observation for the regression. The independent variables then become "dummy" variables whose values for a particular cell (observation) are either zero or one depending on whether the individuals in the cell do or do not belong to the subgroup defined by that variable. In this grouped logit model even a small number of categories for several independent variables multiplies the number of different cells rapidly. This method therefore requires an appropriately large sample and careful subgrouping in order to develop reliable estimates for all of the regression coefficients. This grouped logit model was determined to be well suited to describing the continuation behavior of recruits based on certain demographic characteristics that were described earlier[Refs. 5 & 6].

The estimate for the retention probability in a given cell is

$$\hat{P} = \frac{R_i}{N_i}$$

where R_i is the number of individuals that reenlisted and N_i is the total number in the ith cell. Hence, the model can be rewritten as

$$\log\left(\frac{R_i}{N_i - R_i}\right) = \alpha + \beta X_i$$

In this form the model is undefined for $R_i = 0$ or $N_i = R_i$. To eliminate this difficulty and to improve the approximation to the normal distribution in cells with small sample size the following adjustment suggested by Cox [Ref. 7] was made.

$$\log\left(\frac{R_i + \frac{1}{2}}{N_i - R_i + \frac{1}{2}}\right) = \alpha + \beta X_i$$

Because there is greater variance in the mid range (near $p = .5$) of the dependent variable a correction for heteroscedasticity must be applied to both sides of the equation [Ref. 10]. For the above model Cox suggests the following estimate of the variance.

$$\hat{V}_i = \frac{(N_i + 1)(N_i + 2)}{N_i(R_i + 1)(N_i - R_i + 1)}$$

After dividing all of the variables for each observation through by its estimated standard deviation $S_i = \sqrt{\hat{V}_i}$ to correct for the heteroscedasticity, the final regression model looked like

$$\log\left(\frac{R_i + \frac{1}{2}}{N_i - R_i + \frac{1}{2}}\right)\left(\frac{N_i(R_i + 1)(N_i - R_i + 1)}{(N_i + 1)(N_i + 2)}\right)^{\frac{1}{2}} = (\alpha + \beta X_i)\left(\frac{N_i(R_i + 1)(N_i - R_i + 1)}{(N_i + 1)(N_i + 2)}\right)^{\frac{1}{2}}$$

In this form the only cells that could not be used in the regression were ones which contained no observations. For a more detailed development of this model see refs. 7 & 10.

The actual regression was accomplished using the multiple regression routine contained in the Statistical Package for the Social Sciences (SPSS), Release 8.0, Version H [Ref. 9].

2. Regression Results

The regression results for both the direct and delayed pipelines are tabulated in figures 7 & 8 respectively.[2] The formulas used to develop predicted retention numbers and percentages from the regression equation are shown in figure 9. For the delayed pipeline 81.5% of the between cell retention variability was explained by the regression while 98.3% was explained in the direct school case. Some of the difference may be attributable to population size since the direct school population was much larger. It may also indicate that other factors not in the regression play a greater role in the delayed pipeline. It is certainly reasonable to expect that the discriminating information used in the selection process for this group should involve more than just a persons recruiting data.

---

[2] The direct "A" school regression was done in order to compare the regression coefficients and estimated retention percentages between the two pipelines for each cell in the model. The direct "A" school regression was not needed in the prediction process.

Direct Pipeline
Regression Results

Var	B	Std Error	T
MG1	-2.673	.147	18.21
MG2	-2.507	.0993	25.23
MG3U	-2.438	.102	23.94
MG3L	-2.415	.111	21.67
MG4	-2.313	.128	18.04
ED2	.1342	.0900	1.49
ED3	.3499	.0818	4.28
ED4	.4343	.0962	4.51
AGE1	- .1331	.0625	2.13
AGE2	- .1039	.0506	2.06
DEP	.5455	.0715	7.62
RACE	.5449	.0675	8.08
CONST (incl AGE3 + ED1)	.2978		

$R^2 = .983$

Total Regression F Ratio = 812.5

Degrees of Freedom = 12/167

Figure 7

Delayed Pipeline
Regression Results

Var	B	St. Error	T
MG1	-1.394	.573	2.43
MG2	-1.596	.325	4.91
MG3U	-1.679	.314	5.34
MG3L	-1.538	.301	5.11
MG4	-1.276	.308	4.15
ED2	.1044	.202	.518
ED3	- .04282	.188	.228
ED4	.2328	.290	.802
AGE1	- .2764	.192	1.44
AGE2	- .1850	.173	1.07
DEP	.8354	.233	3.59
RACE	.5302	.159	3.34
CONST (incl AGE3 + ED1)	- .0888		

R^2 = .815

Total Regression F Ratio = 34.97

Degrees of Freedom = 12/95

Figure 8

Calculation
of
Predicted Reenlistment
Numbers

$$(1) \qquad \log\left(\frac{R_i + \frac{1}{2}}{N_i - R_i + \frac{1}{2}}\right) = \alpha + \beta X_i = Z_i$$

$$R_i = \max\left[\frac{(N + \frac{1}{2})e^{Z_i} - \frac{1}{2}}{1 + e^{Z_i}},\ 0\right]$$

Calculation
of
Predicted Reenlistment
Percentages

$$(2)^{*} \qquad \log\left(\frac{P_i}{1 - P_i}\right) = \alpha + \beta X_i = Z_i$$

$$P_i = \frac{e^{Z_i}}{1 + e^{Z_i}}$$

FIGURE 9

*Asymptotically equivalent to equation (1) for large N.

A review of the regression coefficients shows that nearly all of the coefficients in the direct pipeline were significant well beyond the .05 level. The least significant was the education equal to eleven years coefficient and even it was significant at the .1 level.

A definite pattern emerged in this group. First an increase in mental group was monotonically associated with a decrease in retention. This is probably associated with job opportunity outside the Navy. The job situation may also be the reason why race (nonwhite) tends to increase retention probability. The coefficient for dependents also indicates increased retention but in this case it is more likely to be the result of the perceived risk in getting out of the Navy, a very secure job environment. The increase in retention associated with an increase in education seems contrary to the logic above. However, since high school completion has long been the best single predictor of first term completion it is probably the low first term loss rate that causes these coefficients to be monotonically increasing.

Interestingly none of the education coefficients were significant in the delayed population regression, and only the AGE1 ($\leq$ 17 years of age) coefficient was significant at the .1 level among the age variables. The monotonic relationship with respect to mental group has also been eliminated. In fact mental group 1 enjoys the second

best retention level only slightly behind mental group 4. These individual comparisons are another strong indication that other factors not used in this model are playing an increased role in determining the behavior for the delayed group.

3. Discriminant Analysis Results

It should be noted that the regression model was a grouped model and does not predict or describe individual behavior. A discriminant analysis was attempted on the individual data and less than 2% of the variability was successfully explained. A review of Appendix H shows why. The population spread defined by the discriminant function was so large in comparison to the difference between population means that a near total overlap occurred. Individual prediction rates (68.49% overall for the delayed pipeline) in this situation although definitely better than 0.5 (coin toss odds) are just not good enough to be useful.

IV. RESULTS AND CONCLUSIONS

A. AGGREGATE RESULTS

Figure 10 shows that significant improvements are available according to the best guess estimates. The increase in pure numbers (for comparison only) of 661 trained petty officers represents nearly a 50% improvement in the retention rate for "A" school graduates. The worst case estimate shows a tradeoff that may be entirely acceptable because of the very great savings in school loading. In fact, if school loading could be reduced in the proportions indicated it is highly likely that the loss in reenlistment could be more than compensated for by the availability of those instructors and support personnel no longer required at the training centers. Even the worst case estimate, therefore, suggests the need for a shift in the present distribution until a more balanced reenlistment picture is achieved.

B. CELL BY CELL COMPARISONS

Appendices B through E present cell by cell reenlistment estimates for various conbinations of first year loss estimates and delayed or direct pipeline regression predictions applied to either the delay or direct population. Appendix F is a comparison of the reenlistment differences between Appendix C (the direct A school reenlistment predictions from the direct A school regression) and Appendix D

AGGREGATE RETENTION

RESULTS

	Graduates (N)	% Loss[1] (PL)	Adjusted Population[2] (AN)	Number Retained (R)	% Retained	Net Gain (Loss)
Direct "A" School Population (Actual)	26177			2649	10.1	
Best Guess Estimate		15%	22264	3310[3]	14.9	661
Worst Case Estimate		42%	15162	2255[3]	14.9	(394)

1. See Section III.A.2 for Explanation.
2. $AN = N(1 - P_L)$.
3. $R = \sum_{i=1}^{240} \max\left[\frac{(AN_i + \frac{1}{2})e^{Z_i} - \frac{1}{2}}{1 + e^{Z_i}}, 0\right]$

FIGURE 10

(the reenlistment prediction for the direct A school population through the delayed A school regression after adjusting for the best guess first year loss). This comparison clearly shows that the reenlistment differences are far from constant across all cells. Some cells (the negative values) actually favor the direct pipeline. The delayed pipeline is very highly favored in mental group 1, less favored in mental groups 2 and 4. Mental groups 3U and 3L each have some values favoring the direct pipeline and are therefore inconclusive as a group.

Education equal to twelve years shows little preference for either pipeline. Education greater than 12 is the most pronounced in favor of the delayed pipeline followed in order by education equal to eleven years and then less than eleven years.

An increase in age generally favors the delayed pipeline but ages 18, 19 and 20 are very closely grouped. Both having dependents and being non-white increase expected retention in nearly all cells.

The implication contained in these results is that the delayed pipeline may be used optimally (at least in the mathematical sense) to improve retention if applied in some complex manner that accounts for cell variations. The numbers in Appendix F clearly define the cells with the greatest potential for percentage increases. Unfortunately, many of the high value cells are very sparsely populated

(many are empty). Appendix G tables the 1973 population cell distribution. It should be used in conjunction with Appendix F.

The total picture presented in these tables is too complex to be fully described and understood with this simple explanation. The tables themselves are only a part of the situation. To gain a good understanding of the numerical parts of the problem it is necessary to review the tables carefully, systematically and probably numerous times from different viewpoints. It is also just as important to realize that cause and effect are not in any way described or implied by the underlying mathematics. The mere existence of some relationships is all that is presented here and cause and effect relationships are still to be examined.

V . SUMMARY AND RECOMMENDATIONS

A very great potential for improving retention of school trained personnel while at the same time significantly reducing training cost is indicated by this analysis. In terms of reenlistment percentage the delayed pipeline enjoys a dramatic advantage. With respect to possibly improving the total number of trained man years the delayed pipeline also appears to offer an opportunity for improvement especially if it can be used systematically according to demographic profile.

However, because the recruiting, training and personnel management interfaces are so complex, it is possible, even likely, that some aspect of the problem may have been overlooked in either the data collection or the analysis that could alter or completely nullify the results. Even if this is not the case the results still must be studied in the light of the total recruiting, training and manpower management interaction.

Two specific elements that need immediate consideration are:

1. The addition of the required data to accurately define school attendance and attrition.
2. A precise method to identify those in the delayed pipeline that are only there because of temporary lack of school availability.

With the addition of this data the complete process could then be mathematically modeled.

It is therefore recommended that the entire process be reviewed in the light of the results presented here. It is absolutely essential that this review be conducted by a team of individuals representing detailed knowledge at all of the interfacing elements. In this environment it may be possible to determine the underlying cause and effect relationships which would be essential to the development of any effective new policies.

For at least the next twenty years the recruitable population will continue to decline making manpower <u>the</u> binding constraint around which all other decisions must revolve. If the results of this thesis are accurate, they represent at least the potential to reduce recruiting requirements by perhaps 10% or more. This opportunity should not be overlooked.

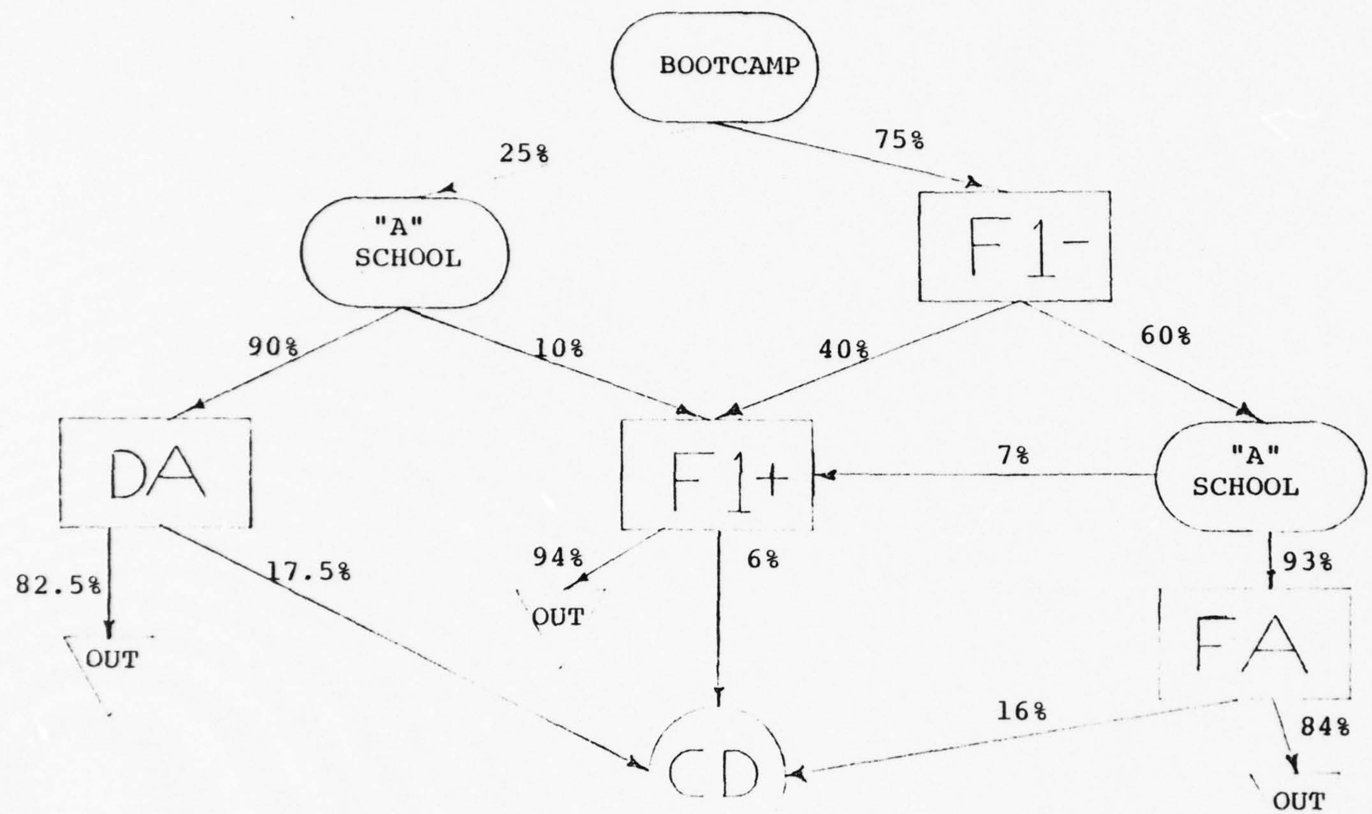
APPENDIX A

The manning profiles presented in figure 2 were derived by applying a "rough guess" estimate of the pipeline distribution percentages shown on the following pages to an arbitrarily chosen number of Recruit Training Center graduates (20,000 graduates in each 3-month increment) until all of the various manning categories reached their steady state value. This was done before any of the actual values had been determined.

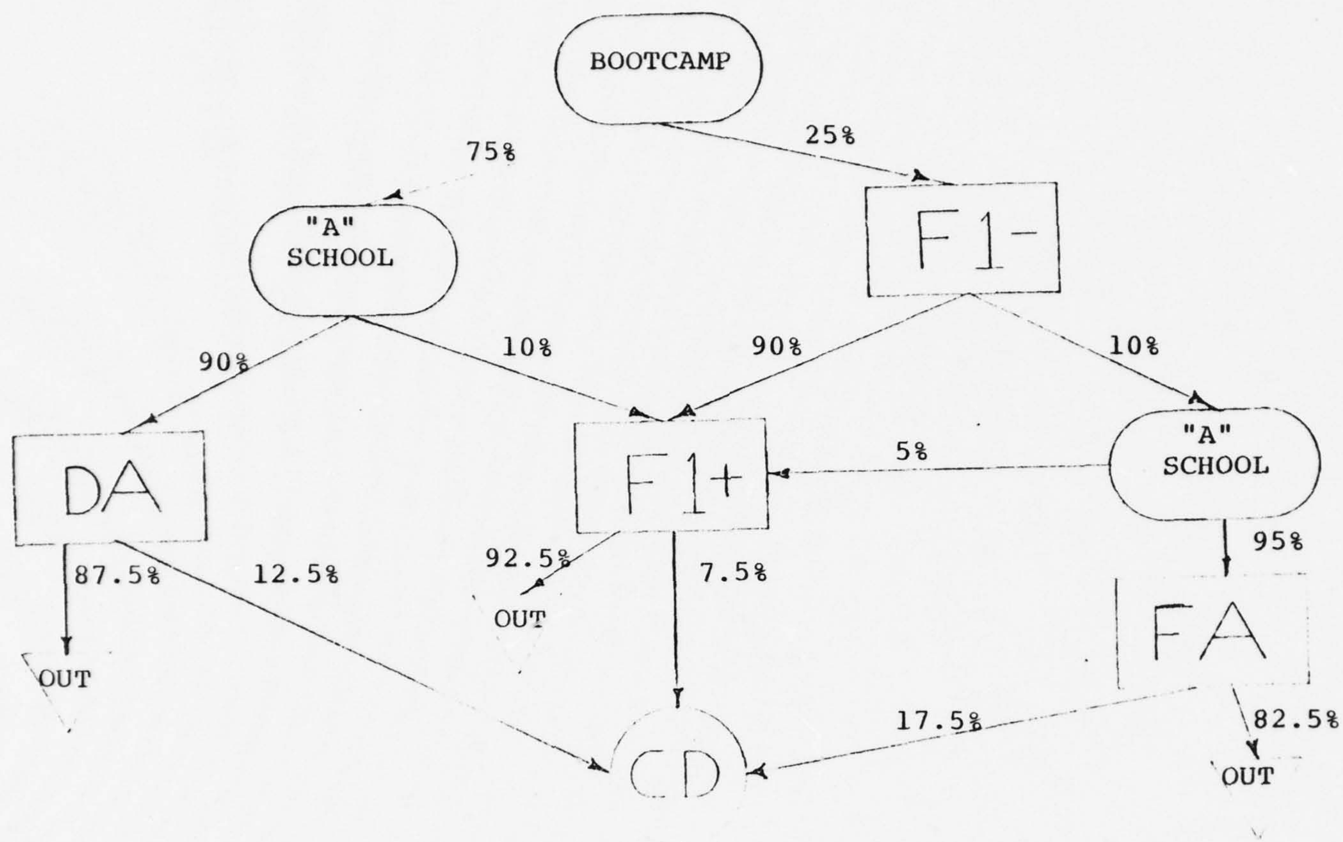
For simplicity no losses during an enlistment period were considered and "A" school length was set at a constant value of three months. All of the delayed "A" school individuals were assumed to have spent exactly one year in the fleet before going to "A" school. Also, all career designated personnel were assumed to stay through twenty years of service.

Because these assumptions were held constant over both distribution strategies any resulting inaccuracies should not significantly affect the main objective of the comparison, i.e., to estimate the general nature and acceptability of the manpower profile change that would result from an increased use of the delayed "A" school pipeline.

MODIFIED SYSTEM



PRESENT SYSTEM
(estimate)



APPENDIX B

DELAYED "A" SCHOOL RETENTION
(Expressed as a %)

WHITE

MG	AGE	NO DEPENDENTS YEARS EDUCATION				DEPENDENTS YEARS EDUCATION			
		<11	11	12	>12	<11	11	12	>12
	≤17	14.7	16.1	14.2	17.9	28.4	30.6	27.6	33.4
1	18-19	15.9	17.3	15.3	19.2	30.3	32.6	29.4	35.5
	≥20	18.5	20.1	17.9	22.3	34.4	36.8	33.4	39.8
	≤17	12.3	13.5	11.9	15.1	24.5	26.5	23.7	29.1
2	18-19	13.4	14.6	12.9	16.3	26.2	28.3	25.4	31.0
	≥20	15.7	17.1	15.1	19.0	30.0	32.2	29.1	35.1
	≤17	11.5	12.6	11.0	14.1	23.0	24.9	22.2	27.4
3U	18-19	12.4	13.6	12.0	15.2	24.7	26.6	23.9	29.2
	≥20	14.6	15.9	14.1	17.7	28.2	30.4	27.4	33.2
	≤17	13.0	14.2	12.5	15.8	25.6	27.6	24.8	30.3
3L	18-19	14.1	15.4	13.5	17.1	27.4	29.5	26.5	32.2
	≥20	16.4	17.9	15.9	19.9	31.2	33.5	30.3	36.4
	≤17	16.2	17.7	15.7	19.7	30.9	33.2	30.0	36.1
4	18-19	17.5	19.1	16.9	21.1	32.9	35.2	31.9	38.2
	≥20	20.4	22.1	19.7	24.4	37.1	39.5	36.1	42.7

DELAYED "A" SCHOOL RETENTION

(Expressed as a %)

NONWHITE

MG	AGE	NO DEPENDENTS YEARS EDUCATION				DEPENDENTS YEARS EDUCATION			
		<11	11	12	>12	<11	11	12	>12
	<17	22.7	24.5	21.9	27.0	40.3	42.8	39.3	46.0
1	18-19	24.3	26.3	23.5	28.8	42.5	45.1	41.5	48.3
	≥ 20	27.9	30.0	27.0	32.8	47.1	49.7	46.0	52.9
	≤ 17	19.3	21.0	18.6	23.2	35.5	38.0	34.6	41.0
2	18-19	20.8	22.5	20.1	24.9	37.7	40.2	36.7	43.3
	≥ 20	24.0	25.9	23.2	28.5	42.1	44.7	41.1	47.9
	≤ 17	18.0	19.6	17.4	21.7	33.7	36.0	32.7	39.0
3U	18-19	19.4	21.1	18.8	23.3	35.7	38.2	34.8	41.2
	≥ 20	22.5	24.4	21.8	26.8	40.1	42.6	39.1	45.8
	≤ 17	20.2	22.0	19.5	24.2	36.9	39.4	35.9	42.5
3L	18-19	21.7	23.6	21.0	26.0	39.0	41.6	38.0	44.7
	≥ 20	25.1	27.1	24.3	29.7	43.5	46.1	42.5	49.3
	≤ 17	24.8	26.8	24.0	29.4	43.2	45.7	42.1	48.9
4	18-19	26.5	28.6	25.7	31.3	45.4	48.0	44.4	51.2
	≥ 20	30.3	32.5	29.4	35.4	50.0	52.6	49.0	55.8

APPENDIX C

DIRECT "A" SCHOOL RETENTION
(Expressed as a %)

WHITE

MG	AGE	NO DEPENDENTS YEARS EDUCATION				DEPENDENTS YEARS EDUCATION			
		<11	11	12	>12	<11	11	12	>12
	≤17	6.1	6.9	8.4	9.1	10.0	11.3	13.7	14.7
1	18-19	6.2	7.1	8.6	9.3	10.3	11.6	14.0	15.1
	≥20	6.9	7.8	9.5	10.2	11.3	12.7	15.3	16.4
	≤17	7.1	8.0	9.8	10.5	11.6	13.1	15.7	16.9
2	18-19	7.3	8.2	10.0	10.8	11.9	13.4	16.1	17.3
	≥20	8.0	9.1	11.0	11.9	13.1	14.7	17.6	18.8
	≤17	7.6	8.5	10.4	11.2	12.4	13.9	16.7	17.9
3U	18-19	7.8	8.8	10.7	11.5	12.7	14.2	17.1	18.3
	≥20	8.5	9.6	11.7	12.6	13.9	15.6	18.6	19.9
	≤17	7.7	8.7	10.6	11.4	12.6	14.2	17.0	18.2
3L	18-19	7.9	9.0	10.9	11.7	12.9	14.5	17.4	18.7
	≥20	8.7	9.8	11.9	12.8	14.1	15.9	19.0	20.3
	≤17	8.5	9.6	11.6	12.5	13.8	15.4	18.5	19.8
4	18-19	8.7	9.8	11.9	12.8	14.1	15.8	18.9	20.2
	≥20	9.6	10.8	13.0	14.0	15.4	17.3	20.6	22.0

DIRECT "A" SCHOOL RETENTION
(Expressed as a %)

NONWHITE

MG	AGE	NO DEPENDENTS YEARS EDUCATION				DEPENDENTS YEARS EDUCATION			
		<11	11	12	>12	<11	11	12	>12
	≤17	10.0	11.3	13.7	14.7	16.1	18.0	21.4	22.9
1	18-19	10.3	11.6	14.0	15.0	16.5	18.5	21.9	23.4
	≥20	11.3	12.7	15.3	16.4	18.0	20.1	23.8	25.3
	≤17	11.6	13.1	15.7	16.9	18.5	20.6	24.4	25.9
2	18-19	11.9	13.4	16.1	17.3	18.9	21.1	24.9	26.5
	≥20	13.1	14.7	17.6	18.8	20.6	22.9	26.9	28.6
	≤17	12.4	13.9	16.7	17.9	19.6	21.8	25.7	27.3
3U	18-19	12.7	14.2	17.1	18.3	20.0	22.3	26.2	27.9
	≥20	13.9	15.5	18.6	19.9	21.7	24.1	28.3	30.0
	≤17	12.6	14.2	17.0	18.2	19.9	22.1	26.1	27.7
3L	18-19	12.9	14.5	17.4	18.6	20.4	22.7	26.7	28.3
	≥20	14.1	15.8	18.9	20.3	22.1	24.5	28.7	30.5
	≤17	13.8	15.4	18.5	19.8	21.6	24.0	28.1	29.8
4	18-19	14.1	15.8	18.9	20.2	22.1	24.5	28.7	30.4
	≥20	15.4	17.3	20.6	22.0	23.9	26.5	30.9	32.7

APPENDIX D

Estimated Marginal Retention Percentages by cell for direct "A" school individuals shifted to the delayed "A" school pipeline (Best guess 1st year loss applied)

WHITE

		NO DEPENDENTS YEARS EDUCATION				DEPENDENTS YEARS EDUCATION			
MG	AGE	<11	11	12	>12	<11	11	12	>12
	≤17	12.9	14.4	13.4	17.1	23.7	26.2	25.3	31.4
1	18-19	14.1	15.7	14.5	18.5	25.6	28.3	27.2	33.5
	≥20	15.9	17.7	16.7	21.2	27.7	30.6	30.2	37.0
	≤17	9.6	10.9	10.6	13.8	17.3	19.7	20.1	25.7
2	18-19	10.6	12.0	11.6	15.1	19.0	21.5	21.8	27.7
	≥20	11.7	13.3	13.1	17.1	20.0	22.7	23.8	30.3
	≤17	8.5	9.7	9.6	12.7	15.3	17.5	18.2	23.6
3U	18-19	9.4	10.8	10.5	13.8	16.9	19.2	19.8	25.5
	≥20	10.3	11.8	11.9	15.7	17.5	20.1	21.6	27.8
	≤17	8.6	9.9	10.2	13.6	14.6	16.9	18.6	24.4
3L	18-19	9.5	11.0	11.2	14.9	16.2	18.7	20.3	26.5
	≥20	10.1	11.8	12.4	16.6	16.3	19.0	21.6	28.2
	≤17	10.1	11.7	12.3	16.5	16.3	19.0	21.5	28.1
4	18-19	11.2	13.0	13.6	18.0	18.1	20.9	23.5	30.3
	≥20	11.7	13.7	14.8	19.8	17.8	20.8	24.4	31.8

Estimated Marginal Retention Percentages
by cell for direct "A" school individuals
shifted to the delayed "A" school pipeline
(best guess 1st year loss applied)

<u>NONWHITE</u>

		NO DEPENDENTS YEARS EDUCATION				DEPENDENTS YEARS EDUCATION			
MG	AGE	<11	11	12	>12	<11	11	12	>12
	≤17	19.9	22.0	20.7	25.9	33.6	36.7	36.1	43.3
1	18-19	21.6	23.8	22.3	27.7	36.0	39.1	38.4	45.6
	≥20	23.9	26.4	25.2	31.1	37.9	41.4	41.6	49.1
	≤17	15.0	17.0	16.6	21.3	25.1	28.2	29.2	36.3
2	18-19	16.5	18.5	18.0	23.0	27.3	30.5	31.4	38.6
	≥20	17.9	20.2	20.2	25.7	28.0	31.5	33.6	41.3
	≤17	13.4	15.2	15.1	19.6	22.3	25.3	26.7	33.6
3U	18-19	14.8	16.7	16.5	21.2	24.4	27.5	28.9	36.0
	≥20	15.8	18.0	18.4	23.7	24.9	28.2	30.8	38.3
	≤17	13.3	15.3	15.9	20.8	21.0	24.1	26.9	34.3
3L	18-19	14.8	16.9	17.4	22.6	23.1	26.4	29.2	36.7
	≥20	15.4	17.8	19.0	24.8	22.7	26.1	30.3	38.2
	≤17	15.4	17.7	18.9	24.6	22.8	26.2	30.2	38.1
4	18-19	17.0	19.5	20.6	26.6	25.0	28.5	32.6	40.7
	≥20	17.4	20.1	22.2	28.7	24.0	27.6	33.2	41.6

APPENDIX E

Estimated Marginal Reenlistment Percentages Direct "A" School Individuals Shifted to Delayed "A" School Pipeline (Worst case 1st year loss applied)

WHITE

MG	AGE	NO DEPENDENTS YEARS EDUCATION <11	11	12	>12	DEPENDENTS YEARS EDUCATION <11	11	12	>12
	≤17	8.5	9.3	8.2	10.4	16.5	17.8	16.0	19.4
1	18-19	9.2	10.1	8.9	11.2	17.6	18.9	17.1	20.6
	≥20	10.7	11.7	10.4	12.9	19.9	21.3	19.4	23.1
	≤17	7.2	7.8	6.9	8.8	14.2	15.4	13.8	16.9
2	18-19	7.8	8.5	7.5	9.5	15.2	16.4	14.7	18.0
	≥20	9.1	9.9	8.8	11.0	17.4	18.7	16.9	20.3
	≤17	6.7	7.3	6.4	8.1	13.3	14.4	12.9	15.9
3U	18-19	7.2	7.9	6.9	8.8	14.3	15.5	13.8	17.0
	≥20	8.5	9.2	8.2	10.3	16.4	17.6	15.9	19.3
	≤17	7.5	8.2	7.3	9.2	14.8	16.0	14.4	17.6
3L	18-19	8.2	8.9	7.9	9.9	15.9	17.1	15.4	18.7
	≥20	9.5	10.4	9.2	11.5	18.1	19.4	17.6	21.1
	≤17	9.4	10.3	9.1	11.4	17.9	19.2	17.4	20.9
4	18-19	10.2	11.1	9.8	12.3	19.1	20.4	18.5	22.2
	≥20	11.8	12.8	11.4	14.1	21.5	22.9	20.9	24.7

Estimated Marginal Reenlistment Percentages
Direct "A" School Individuals Shifted to
Delayed "A" School Pipeline (Worst case 1st
year loss applied)

NONWHITE

		NO DEPENDENTS YEARS EDUCATION				DEPENDENTS YEARS EDUCATION			
MG	AGE	<11	11	12	>12	<11	11	12	>12
	≤17	13.1	14.2	12.7	15.7	23.4	24.8	22.8	26.7
1	18-19	14.1	15.2	13.6	16.7	24.7	26.2	24.1	28.0
	≥20	16.2	17.4	15.7	19.0	27.3	28.8	26.7	30.7
	≤17	11.2	12.2	10.8	13.4	20.6	22.0	20.1	23.8
2	18-19	12.0	13.1	11.6	14.4	21.8	23.3	21.3	25.1
	≥20	13.9	15.0	13.5	16.5	24.4	25.9	23.8	27.8
	≤17	10.5	11.4	10.1	12.6	19.5	20.9	19.0	22.6
3U	18-19	11.3	12.2	10.9	13.5	20.7	22.1	20.2	23.9
	≥20	13.0	14.1	12.6	15.5	23.2	24.7	22.7	26.6
	≤17	11.7	12.7	11.3	14.1	21.4	22.8	20.8	24.6
3L	18-19	12.6	13.7	12.2	15.1	22.6	24.1	22.1	25.9
	≥20	14.5	15.7	14.1	17.2	25.2	26.7	24.6	28.6
	≤17	14.4	15.5	13.9	17.0	25.0	26.5	24.4	28.4
4	18-19	15.4	16.6	14.9	18.2	26.3	27.9	25.7	29.7
	≥20	17.6	18.9	17.0	20.5	29.0	30.5	28.4	32.4

APPENDIX F

PERCENT DIFFERENCE

APPENDIX D MINUS APPENDIX C

WHITE

		NO DEPENDENTS YEARS EDUCATION				DEPENDENTS YEARS EDUCATION			
MG	AGE	<11	11	12	>12	<11	11	12	>12
	≤17	6.8	7:5	5.0	8.0	13.7	14.9	11.6	16.7
1	18-19	7.9	8:6	5.9	9.2	15.3	16.7	13.2	18.4
	≥20	9.0	9:9	7.2	11.0	16.4	17.9	14.9	20.6
	≤17	2.5	2.9	0.8	3.3	5.7	6.6	4.4	8.8
2	18-19	3.3	3.8	1.6	4.3	7.1	8.1	5.7	10.4
	≥20	3.7	4.2	2.1	5.2	6.9	8.0	6.2	11.5
	≤17	0.9	1.2	-.8	1.5	2.9	3.6	1.5	5.7
3U	18-19	1.6	2.0	-.2	2.3	6.2	5.0	2.7	7.2
	≥20	1.8	2.2	0.2	3.1	3.6	4.5	3.0	7.9
	≤17	0.7	0.9	-.7	1.9	2.0	2.7	1.6	6.2
3L	18-19	1.6	2.0	0.3	3.2	3.3	4.2	2.9	7.8
	≥20	1.4	2.0	0.5	3.8	2.2	3.1	2.6	7.9
	≤17	1.6	2.1	0.7	4.0	2.5	3.6	3.0	8.3
4	18-19	2.5	3.2	1.7	5.2	4.0	5.1	4.6	10.1
	≥20	2.1	2.9	1.8	5.8	2.4	3.5	3.8	9.8

PERCENT DIFFERENCE

APPENDIX D MINUS APPENDIX C

NONWHITE

MG	AGE	NO DEPENDENTS YEARS EDUCATION <11	11	12	>12	DEPENDENTS YEARS EDUCATION <11	11	12	>12
	≤17	9.9	10.7	7.0	11.2	17.5	18.7	14.7	20.4
1	18-19	11.3	12.2	8.3	12.7	19.5	20.6	16.5	22.2
	≥20	12.6	13.7	9.9	14.7	19.9	21.3	17.8	23.8
	≤17	3.6	3.9	0.9	4.4	6.6	7.6	4.8	10.4
2	18-19	4.6	5.1	1.9	5.7	8.4	9.4	6.5	12.1
	≥20	4.8	5.5	2.6	6.9	7.4	8.6	6.7	12.7
	≤17	1.0	1.3	-1.6	1.7	2.7	3.5	1.0	6.3
3U	18-19	2.1	2.5	-.6	2.9	4.4	5.2	2.7	8.1
	≥20	1.9	2.5	-.2	3.8	3.2	4.1	2.5	8.3
	≤17	0.7	0.9	-1.1	2.6	1.1	2.0	0.8	6.6
3L	18-19	1.9	2.4	0.0	4.0	2.7	3.7	2.5	8.4
	≥20	1.3	2.0	0.1	4.5	0.6	1.6	1.6	7.7
	≤17	1.6	2.3	0.4	4.8	1.2	2.2	2.1	8.3
4	18-19	2.9	3.7	1.7	6.4	2.9	4.0	3.9	10.3
	≥20	2.0	2.8	1.6	6.7	0.1	1.1	2.3	8.9

APPENDIX G

POPULATION DISTRIBUTION[1]

WHITE

MG	AGE	NO DEPENDENTS YEARS EDUCATION <11	11	12	>12	DEPENDENTS YEARS EDUCATION <11	11	12	>12
	≤17	6	13	92	0	1	0	0	0
1	18-19	2	16	444	75	1	0	21	3
	≥20	1	4	96	267	1	2	25	46
	≤17	588	480	1732	2	14	16	26	0
2	18-19	173	454	7251	480	16	36	286	12
	≥20	35	42	1163	1070	13	23	297	185
	≤17	917	529	1231	0	19	16	16	0
3U	18-19	239	494	4264	120	24	38	169	7
	≥20	26	44	614	270	12	23	131	38
	≤17	789	389	573	1	6	6	16	0
3L	18-19	235	341	1990	40	19	29	70	1
	≥20	20	35	312	76	15	6	56	9
	≤17	552	230	220	0	14	3	3	0
4	18-19	178	245	787	10	21	19	24	0
	≥20	21	35	169	24	6	5	23	1

[1]Non-prior-service "bootcamp" graduates with 4-year enlistment contracts

POPULATION DISTRIBUTION[1]

NONWHITE

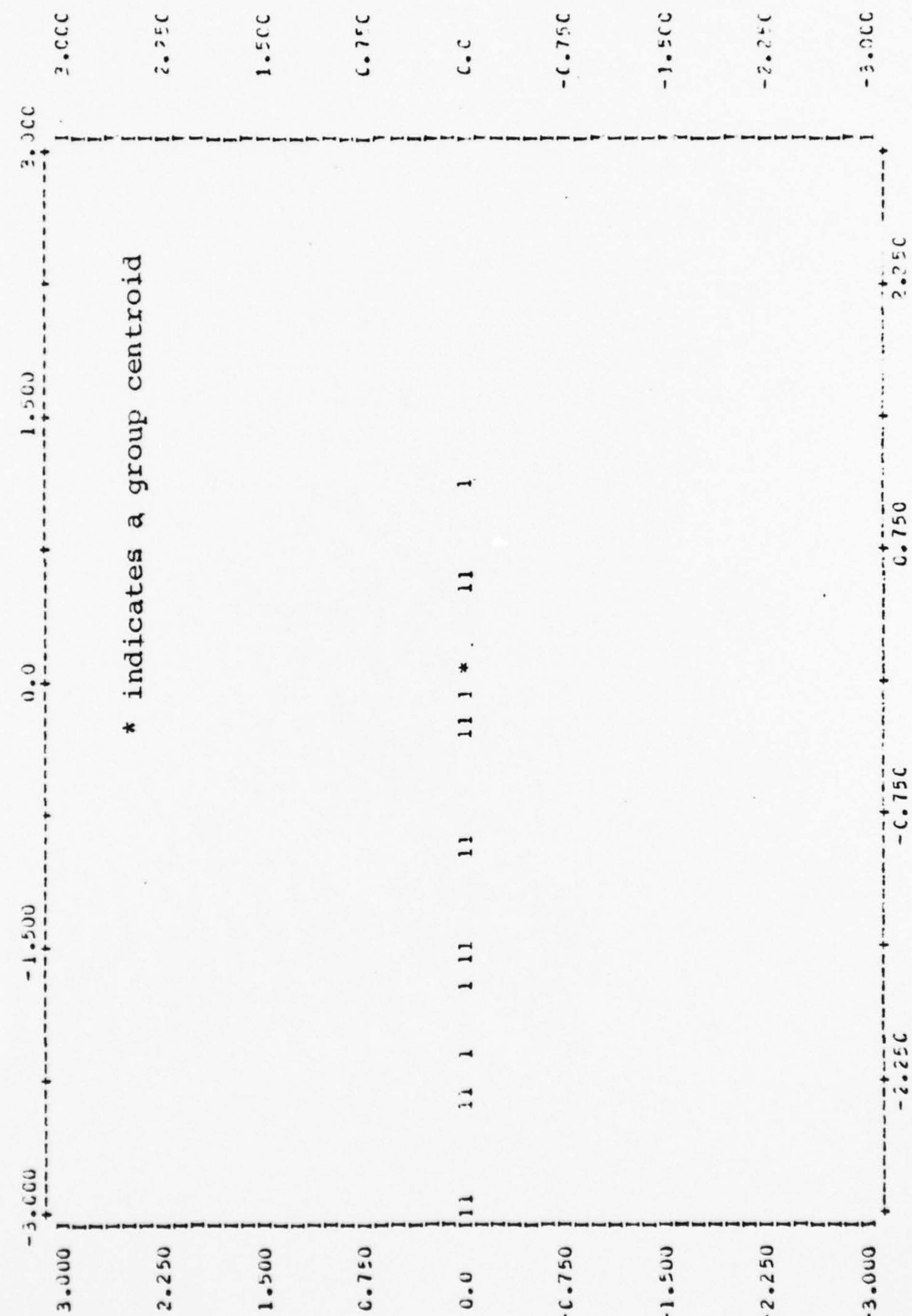
		NO DEPENDENTS YEARS EDUCATION				DEPENDENTS YEARS EDUCATION			
MG	AGE	<11	11	12	>12	<11	11	12	>12
	≤17	0	0	0	0	0	0	0	0
1	18-19	0	0	0	1	0	0	0	0
	≥20	0	0	2	5	0	0	0	0
	≤17	5	7	33	0	0	0	0	0
2	18-19	3	16	130	7	0	1	4	1
	≥20	3	3	36	44	0	0	13	11
	≤17	33	29	63	0	2	1	1	0
3U	18-19	11	32	264	19	0	1	9	1
	≥20	1	8	74	47	2	3	17	14
	≤17	54	77	119	0	2	0	0	0
3L	18-19	26	82	372	22	1	4	15	0
	≥20	5	23	97	69	1	4	9	20
	≤17	91	105	113	0	0	2	2	0
4	18-19	50	139	522	11	3	5	19	1
	≥20	17	29	154	59	3	8	30	11

[1]Non-prior-service "bootcamp" graduates with 4-year enlistment contracts

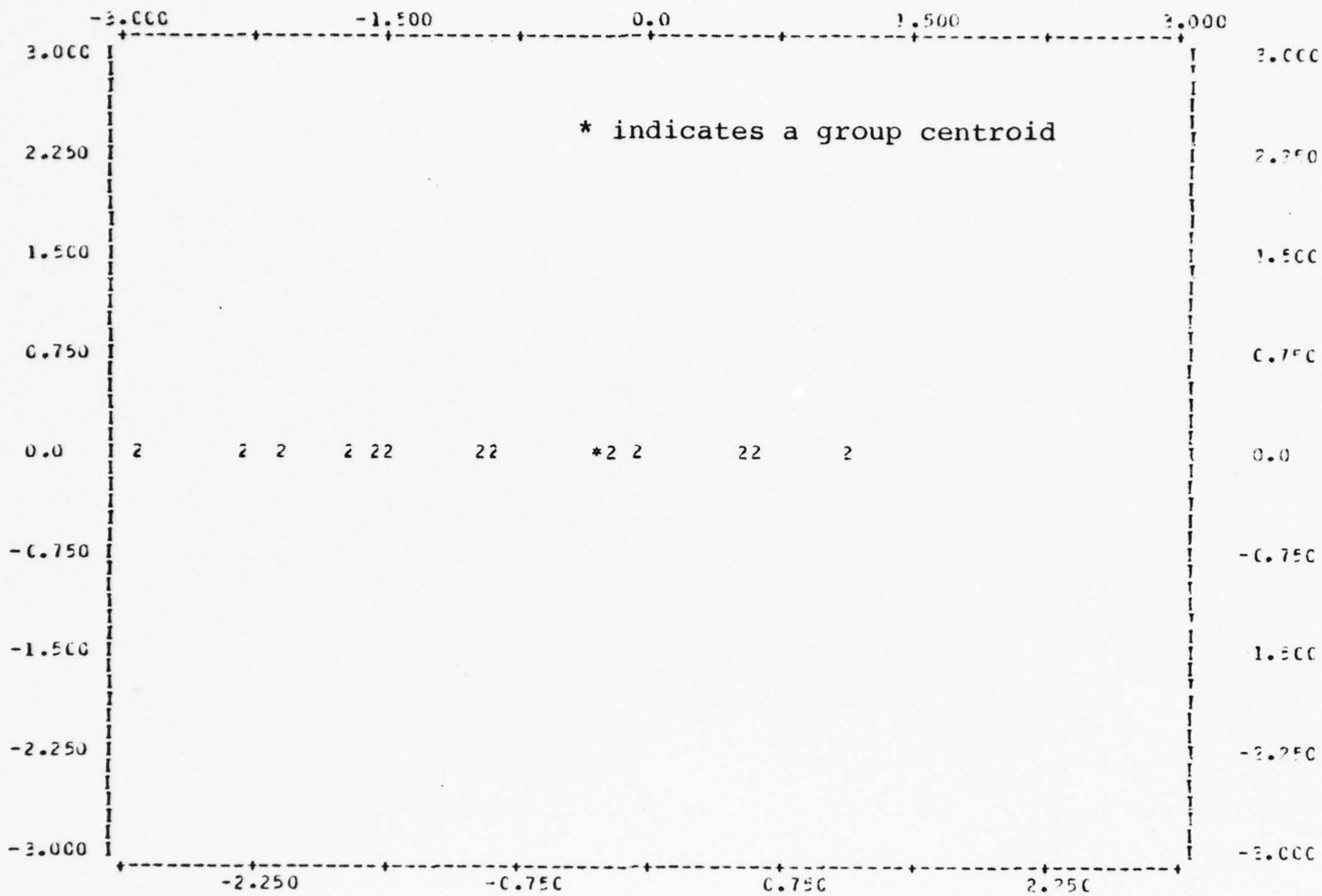
APPENDIX H

DISCRIMINANT ANALYSIS RESULTS

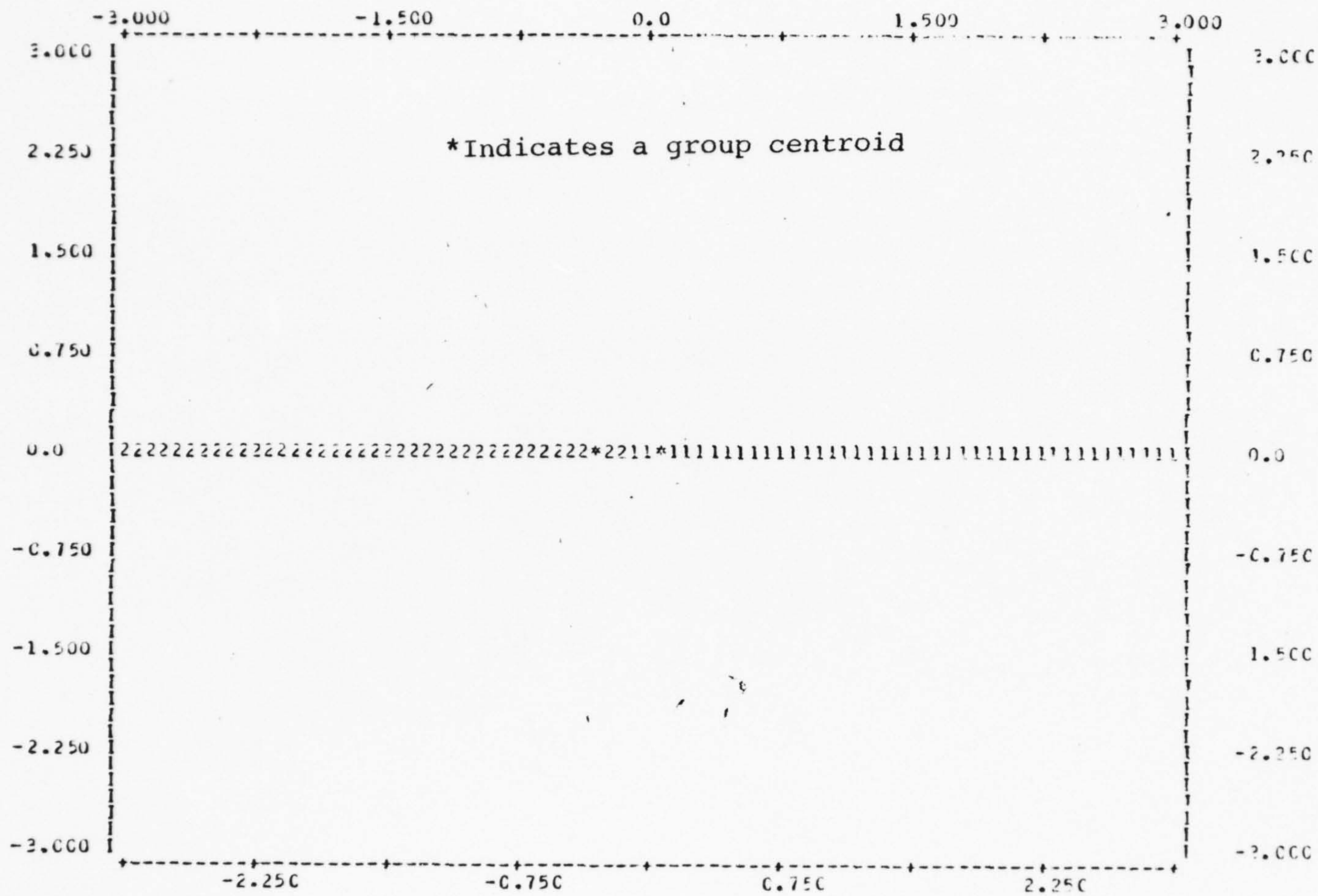
Plot of Discriminant Score for Individuals
Who Were not Retained
(Delayed Pipeline)



Plot of Discriminant Score for
Individuals Who Were Retained
(Delayed Pipeline)



Territorial Map of Discriminant Score



Prediction Results

Actual Group	No. of Cases	Predicted Group Membership GROUP 1	GROUP 2
Group 1 Not Retained	1105	809 (73.2%)	298 (26.8%)
Group 2 Retained	177	108 (61.0%)	69 (39.0%)

Percent of "grouped" cases correctly classified: 68.4%

LIST OF REFERENCES

1. Center for Naval Analysis, Memorandum (CNA) 77-1754-10, "Three-Year Survival and Advancement of Enlisted Men by Occupational Field and Training Type," by Jean W. Fletcher, 28 February, 1978.

2. Center for Naval Analyses, Memorandum (CNA) 78-0659, "Study Plan for the Enlisted Accession and Training (ENACT) Study," by Christopher Jehn, 25 May, 1978.

3. Center for Naval Analyses, Memorandum (CNA) 78-1846, "First-Term Success Predictions for Class A School and General Detail Recruits," by Robert F. Lockman, 21 December, 1978.

4. Center for Naval Analyses, Research Contribution, CRC 338, "A Revised Screen Model for Recruitment Planning," by Robert F. Lockman and Patrice L. Gordon, August, 1977.

5. Center for Naval Analyses, Research Contribution, CRC 345, "The Prediction of Attrition from Military Service," by John T. Warner, September 1978.

6. Center for Naval Analyses, Professional Paper 177, "Predicting Attrition: A Test of Alternative Approaches," by Robert F. Lockman and John T. Warner, March, 1977, Presented at the OSD/ONR Conference on Enlisted Attrition Xerox International Training Center, Leesburg, Virginia, 4-7 April, 1977.

7. Cox, D.R., The Analysis of Binary Data, pp. 30-35, Spottiswoode, Ballantyne & Co., Ltd., 1970.

8. Evanco, William, An Analysis of Delayed Entry into Class A Schools, Draft of Research Contribution, Institute of Naval Studies, Center for Naval Analyses.

9. Nie, Norman H., and others, Statistical Package for the Social Sciences, Second Edition, pp. 320-367, McGraw-Hill, 1975.

10. Pindyck, Robert S. and Rubinfeld, Daniel L., Econometric Models and Economic Forecasts, pp. 97-99, 237-251, McGraw-Hill, Inc., 1976.

11. U.S. Bureau of the Census, Statistical Abstract of the United States: 1977 (98th Annual Edition), pp. 6,7, Washington, D.C., 1977.

INITIAL DISTRIBUTION LIST

		No. Copies
1.	Defense Documentation Center Cameron Station Alexandria, Virginia 22314	2
2.	Library, Code 0142 Naval Postgraduate School Monterey, California 93940	2
3.	Assoc. Prof. James K. Hartman, Code 55Hh Department of Operations Research Naval Postgraduate School Monterey, California 93940	1
4.	Chairman, Code 55 Department of Operations Research Naval Postgraduate School Monterey, California 93940	1
5.	Mr. William Evanco Center for Naval Analyses Washington, D.C. 22209	1
6.	LCDR N. A. Commons, Jr. 1426 Casa Linda Drive Corpus Christi, Texas 78411	1
7.	Chief of Naval Operations Attn: OP964D Department of the Navy Washington, D.C. 20350	1